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SOME SENSITIVITY AND PERFORMANCE CHARACTERISTICS OF THE EXPLOSIVES H-6 AND TRITONAL

MASON AND HANGER - SILAS MASON COMPANY, INC.

TECHNICAL REPORT AFATL-TR-74-104

JUNE 1974

AIR FORCE ARMAMENT LABORATORY

AIR FORCE SYSTEMS COMMAND • UNITED STATES AIR FORCE

EGLIN AIR FORCE BASE, FLORIDA

Some Sensitivity And Performance Characteristics Of The Explosives H-6 And Tritonal

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FOREWORD

This project was conducted at the U. S. Atomic Energy Commission's Pantex Plant, which is located at Amarillo, Texas, and operated by Mason & Hanger - Silas Mason Co., Inc. (M&H-SM). All experimental work and analyses were performed by M&H-SM personnel of the Development Division at Pantex Plant under Project Order AT670D-2-0087 with the Air Force Armament Laboratory, Eglin Air Force Base, Florida. Dr. Larry O. Elkins (DLDE) served as project monitor for the Armament Laboratory.

Experimental work began in March 1972 and continued through June 1973.

The following personnel were responsible for the experimental work and/or the preparation of the report.

Project Scientist:	R. J. Slape
Development Scientists:	J. A. Crutchmer
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This technical report has been reviewed and is approved.

FOR THE COMMANDER

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ABSTRACT

The purpose of this investigation was to determine the relative energies of H-6 and Tritonal as measured by the Lawrence Livermore Laboratory (LLL) Cylinder Test, a test which measures relative metal accelerating ability. The two explosives were also submitted to routine tests to determine thermal and handling characteristics. Both explosives were accepted for machining and general handling. One- and two-inch diameter cylinder tests were fired. Although a definite diameter effect was noted with H-6, no such effect was apparent with Tritonal. This report discusses the apparent discrepancy and includes recommendations for further testing. Tritonal and H-6 proved to be less energetic than Composition B, with H-6 more energetic than TNT and Tritonal less energetic than TNT.

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SECTION I

INTRODUCTION

Tritonal and H-6 were tested to determine their relative energies as measured in the LLL Cylinder Test, a measure of metal accelerating ability. One- and two-inch-diameter test articles were fired to investigate diameter effects.

Thermal and impact sensitivity tests were conducted in order to determine the acceptability of H-6 and Tritonal for handling and machining at Pantex.

SECTION II

SUMMARY

Both H-6 and Tritonal were accepted for machining and general handling.

One- and two-inch-diameter cylinders were fired, and a definite diameter effect was observed with H-6. Tritonal did not exhibit a similar effect, and additional testing is recommended (a 2-inch and a 4-inch-diameter cylinder test) to resolve this apparent discrepancy. H-6 proved to be more energetic than Tritonal which, in turn, was less energetic than TNT. Composition B was more energetic than all three of the above.

SECTION III

MACHINING AND GENERAL SAFETY

In accordance with normal Pantex procedures, H-6 and Tritonal were submitted to impact sensitivity tests, differential thermal analysis, and chemical reactivity tests in order to obtain approval for machining.

Impact sensitivity results for Tritonal and H-6 are summarized in Table I, which also includes data for TNT for comparison.

TABLE I. IMPACT SENSITIVITY

Explosive	50% Drop Height (cm)
TNT	105
Tritonal	100
H-6	85

The tests and interpretation of results are discussed in other reports [1,2]. Tritonal and H-6 are only slightly more sensitive than TNT and were accepted for handling and machining, subject to acceptable thermal sensitivities.

Differential Thermal Analysis (DAT) thermograms for Tritonal and H-6 are shown in Figures 1 and 2. The Tritonal thermogram is very similar to that of TNT and is considered to indicate comparable thermal stability. The H-6 thermogram indicates a melting endotherm characteristic of TNT and a rapid decomposition exotherm ($\sim 200°$ C) comparable to RDX.

The chemical stability of H-6 and Tritonal was determined by gas chromatography and the results are shown in Table II. Sample sizes are 250 milligrams, and tests are conducted at 120° C for 22 hours in a 15-psig helium atmosphere.

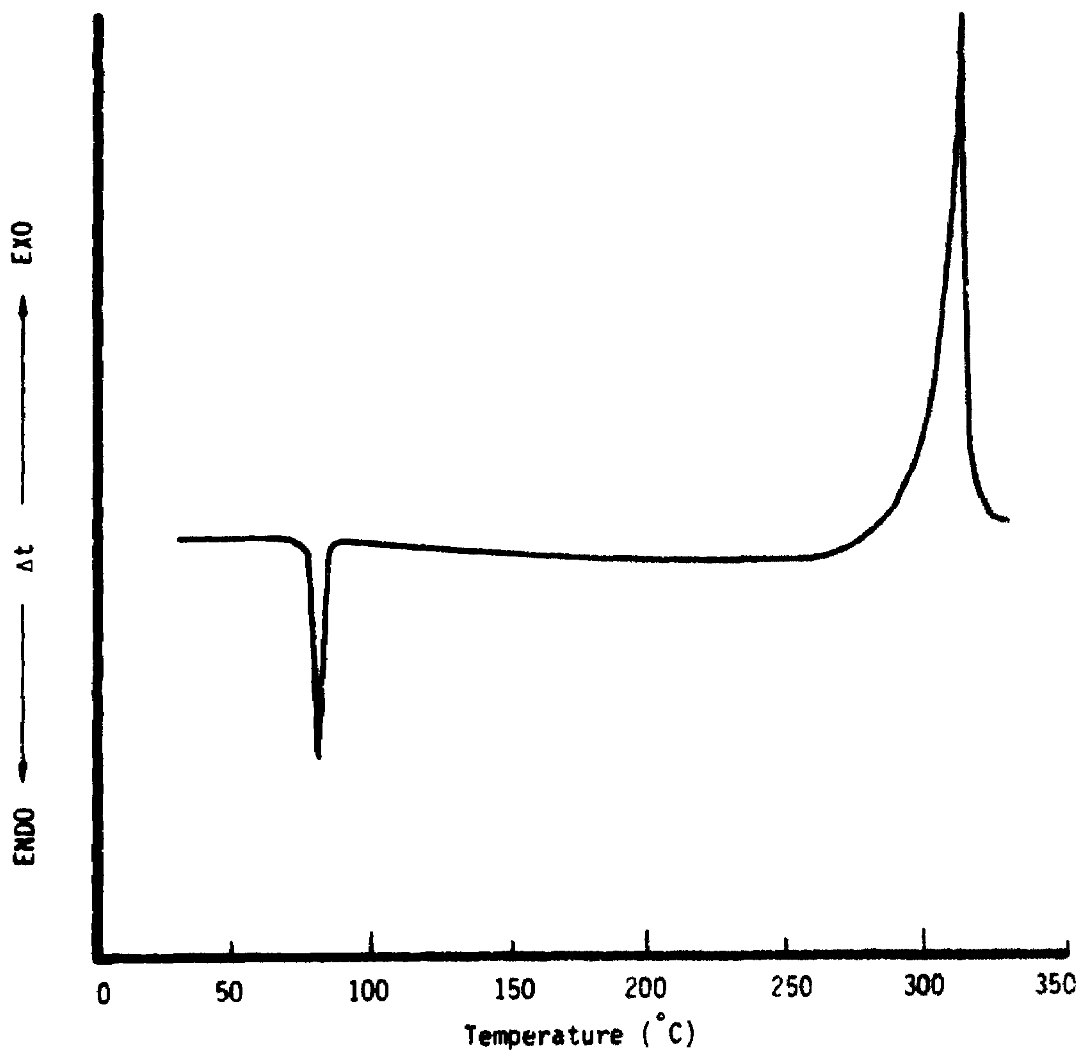

Figure 1. Tritonal Thermogram

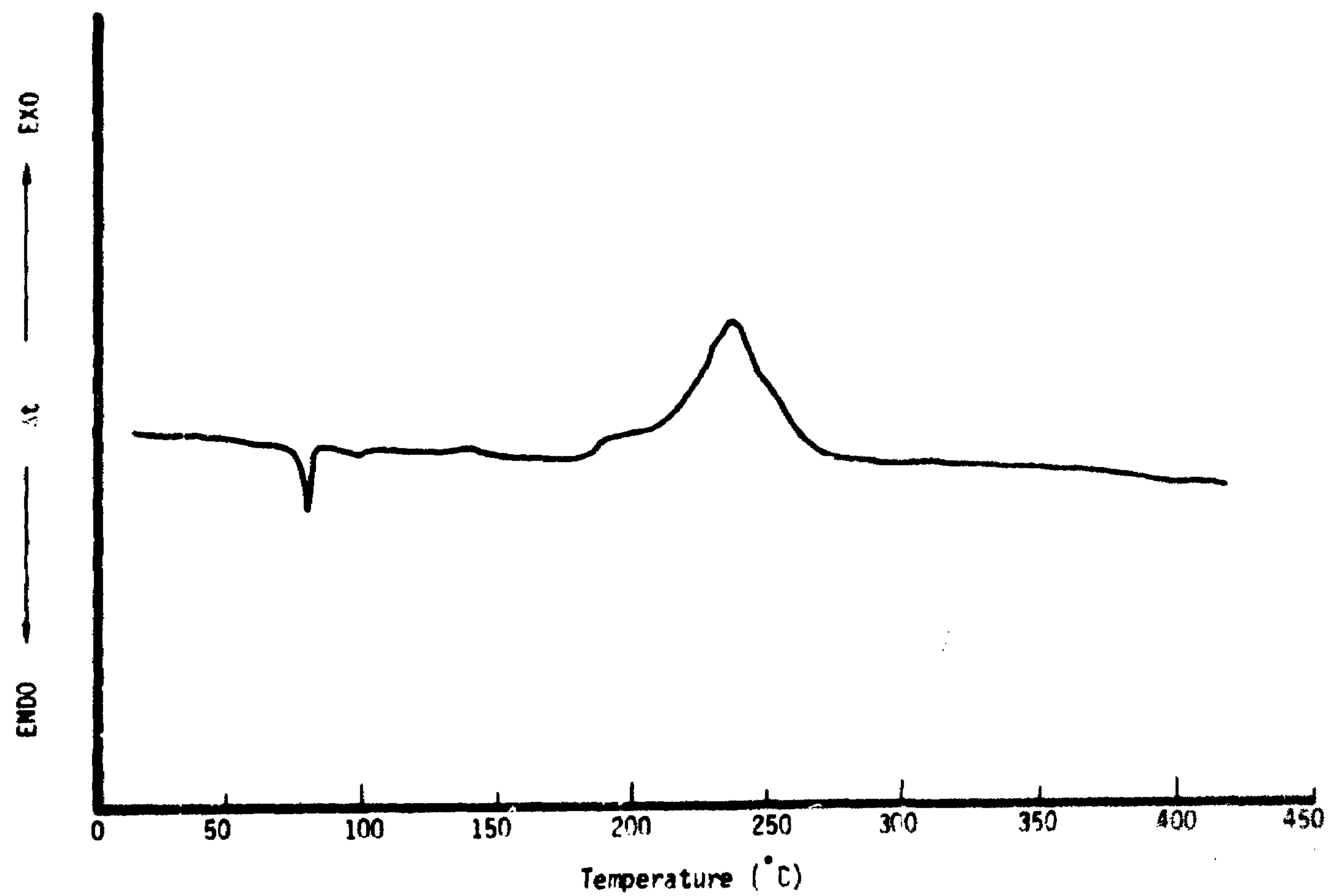

Figure 2. H-6 Thermogram

Table II. Chemical Reactivity

	Gas Evolved (Microliters) at STP					
Explosives	N_2	CO	NO	CO_2	N_2O	Total
Tritonal	9.6	--	--	2.6	--	12.2
H-6	28.2	4.5	30.3	16.5	16.5	96.0

These data indicate much lower levels of reactivity when compared with PBXW-106 (348 microliters total) and PBXW-107 (274 microliters total), and Tritonal and H-6 were accepted for handling and machining.

SECTION IV

PERFORMANCE

Cylinder tests were used to measure the relative metal acceleration abilities and detonation velocities for Tritonal and H-6. The test, analysis, techniques, and interpretations of results are described elsewhere[1,2]. Nominal compositions, test densities, and resulting detonation velocities and Gurney constants are shown in Table III.

Table IV shows expansion wall arrival times and wall velocity data for the 1- and 2-inch diameter cylinder tests on H-6 and Tritonal, with 1-inch data for Composition B shown for comparison. Figures 3 through 7 are plots of the above data and of relative energies. Unfortunately, the 2-inch Tritonal cylinder broke up early (at about 19mm expansion), which made it virtually impossible to completely detect differences in energy due to the contribution of aluminum. The early breakup was attributed to visually detectable voids in the Tritonal samples provided for testing. Although the contribution of the aluminum is evident at fairly small expansions (about 12mm) in the H-6 test, there was no such contribution noted in the Tritonal test. There are at least three possible explanations:

1. Aluminum does not contribute to metal acceleration when it is used with an explosive that is as oxygen deficient as TNT (although it is evident in such late phenomena as cratering, air blast, underwater bubbles, etc.).

2. Aluminum has not contributed to the metal acceleration due to the small diameters tested, i.e., it might become evident in a 4-inch diameter test.

3. The aluminum did contribute in these tests, but only after 19mm, which would have been obscured by the breakup of the cylinder.

In order to reconcile the results, it is recommended that another 2-inch diameter test be conducted, with special precautions to ensure the absence of significant voids in the Tritonal. If there is no apparent contribution from the aluminum in the 2-inch test, then a 4-inch diameter cylinder test would be necessary to determine if the aluminum ever contributes to metal acceleration when used with TNT.

TABLE III. NOMINAL COMPOSITIONS, TEST DENSITIES, DETONATION VELOCITIES, AND GURNEY CONSTANTS

Explosives	TNT (%)	RDX (%)	D-2 Wax (%)	Aluminum (%)	Density (g/cc)	Detonation Velocity (m/sec)	C/M[a]	Gurney Constant[b] (m/sec) 5mm	19mm	26mm
H-6 (1")	30	45	5	20	1.76	7441	0.439	2000	2433	2517
H-6 (2")	30	45	5	20	1.76	7470	0.438	2035	2519	2636
Tritonal (1")	80	--	-	20	1.70	6430	0.424	1826	2249	2316
Tritonal (2")	80	--	-	20	1.69	6520	0.420	1816	2224	--
Composition B	36	64	-	--	1.717	7990	0.425	2350	2756	2821
TNT	100	--	-	--	1.630	6940	0.396	2039	2419	2505

[a] $C/M = \left[\frac{1}{\left(\frac{OD}{ID}\right)^2 - 1}\right]\frac{\rho_c}{\rho_m}$, *where ρ_c is explosive density, ρ_m is metal density and OD and ID are outside and inside diameters of the copper cylinder.*

[b] *Gurney Constant,* $G_i = V_i \sqrt{\frac{1 + 0.5\, C/M}{C/M}}$, *where V_i is the metal velocity at selected expansions.*

TABLE IV. EXPANSION, TIME AND VELOCITY DATA FOR TRITONAL AND H-6

Expansion (mm)	Tritonal (1") t (μsec)	Tritonal (1") v (mm/μsec)	Tritonal (2")[a] t (μsec)	Tritonal (2")[a] v (mm/μsec)	H-6 (1") t (μsec)	H-6 (1") v (mm/μsec)	H-6 (2")[a] t (μsec)	H-6 (2")[a] v (mm/μsec)	Composition B t (μsec)	Composition B v (mm/μsec)
4	4.92	1.05	5.07	1.03	4.40	1.15	4.35	1.17	3.77	1.32
5	5.86	1.08	6.03	1.07	5.25	1.20	5.18	1.22	4.51	1.39
6	6.77	1.11	6.94	1.11	6.07	1.24	5.98	1.27	5.22	1.44
7	7.66	1.14	7.83	1.14	6.86	1.28	6.76	1.30	5.91	1.47
8	8.52	1.17	8.70	1.16	7.63	1.31	7.52	1.33	6.59	1.49
9	9.37	1.19	9.55	1.19	8.39	1.33	8.26	1.36	7.26	1.50
10	10.21	1.21	10.38	1.21	9.14	1.35	8.99	1.38	7.92	1.52
11	11.03	1.23	11.20	1.23	9.87	1.37	9.71	1.40	8.57	1.53
12	11.84	1.25	12.00	1.25	10.60	1.38	10.42	1.42	9.22	1.55
13	12.63	1.26	12.79	1.27	11.32	1.40	11.12	1.44	9.86	1.57
14	13.42	1.28	13.58	1.28	12.03	1.41	11.82	1.46	10.50	1.58
15	14.20	1.29	14.36	1.29	12.74	1.42	12.49	1.47	11.13	1.59
16	14.97	1.30	15.14	1.30	13.44	1.43	13.17	1.48	11.75	1.62
17	15.74	1.31	15.91	1.30	14.14	1.44	13.84	1.49	12.37	1.62
18	16.49	1.33	16.67	1.31	14.83	1.45	14.52	1.50	13.00	1.62
19	17.24	1.33	17.43	1.31	15.52	1.46	15.17	1.51	13.60	1.63
20	17.99	1.34			16.20	1.47	15.83	1.52	14.22	1.64
22	19.47	1.36			17.56	1.48	17.14	1.54	15.43	1.65
24	20.94	1.37			18.90	1.50	18.42	1.56	16.64	1.66
26	22.40	1.37			20.23	1.51	19.70	1.58	17.84	1.67

[a]*Scaling of a 2-inch cylinder to a 1-inch cylinder for a given expansion requires measurement of time as one-half the actual time at double that expansion, and measurement of velocity as actual velocity at double that expansion.*

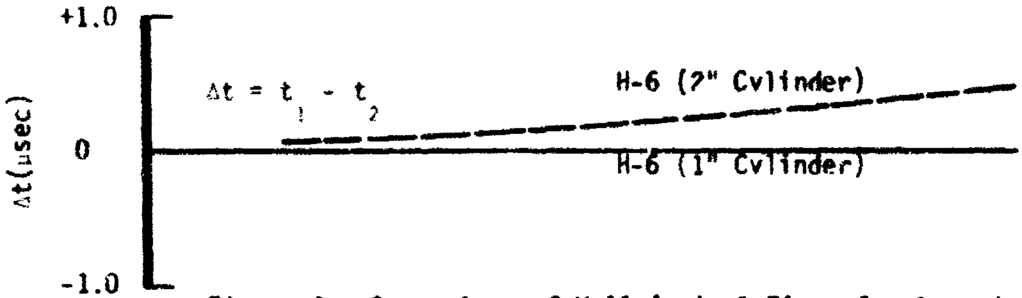

Figure 3. Comparison of Wall Arrival Times for 1- and 2-Inch H-6 Cylinders

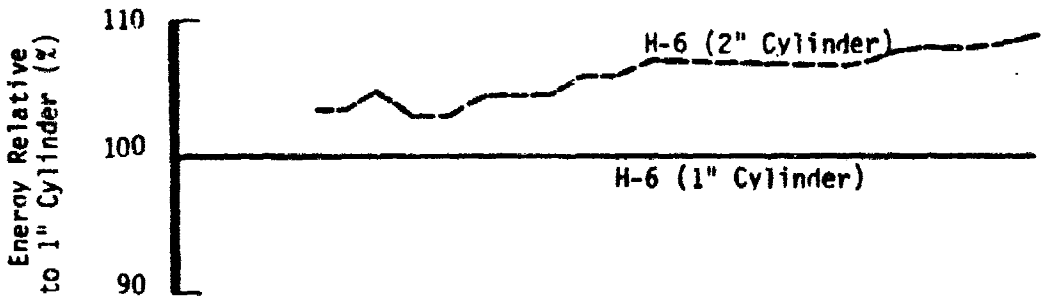

Figure 4. Comparison of Relative Wall Energies for 1- and 2-Inch H-6 Cylinders

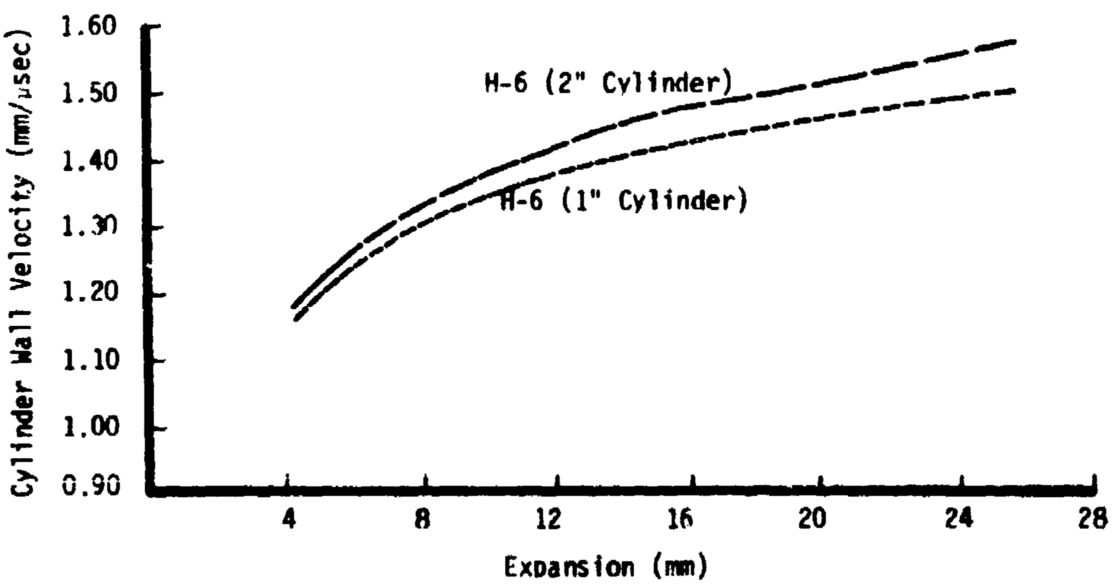

Figure 5. Comparison of Wall Velocities for 1- and 2-Inch H-6 Cylinders

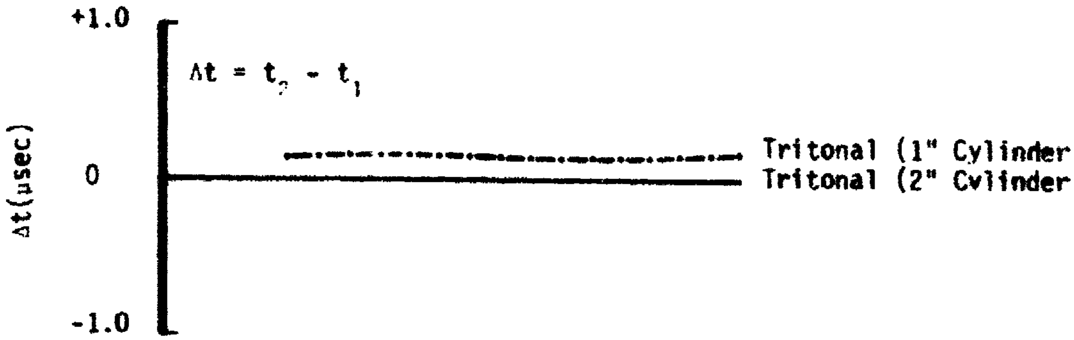

Figure 6. Comparison of Wall Arrival Times for 1- and 2-Inch Tritonal Cylinders

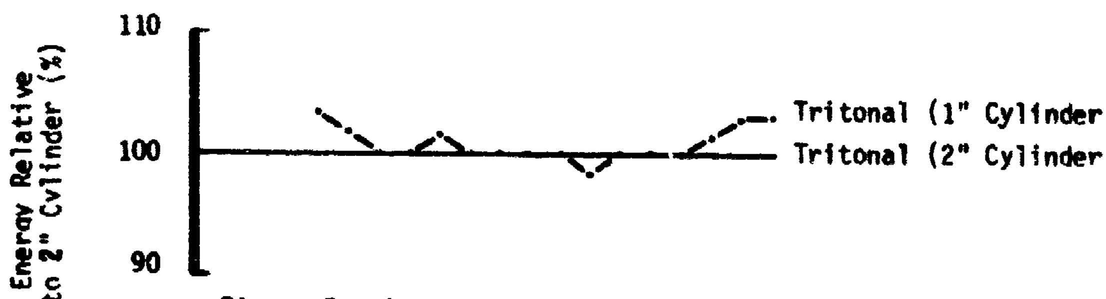

Figure 7. Comparison of Relative Wall Energies for 1- and 2-Inch Tritonal Cylinders

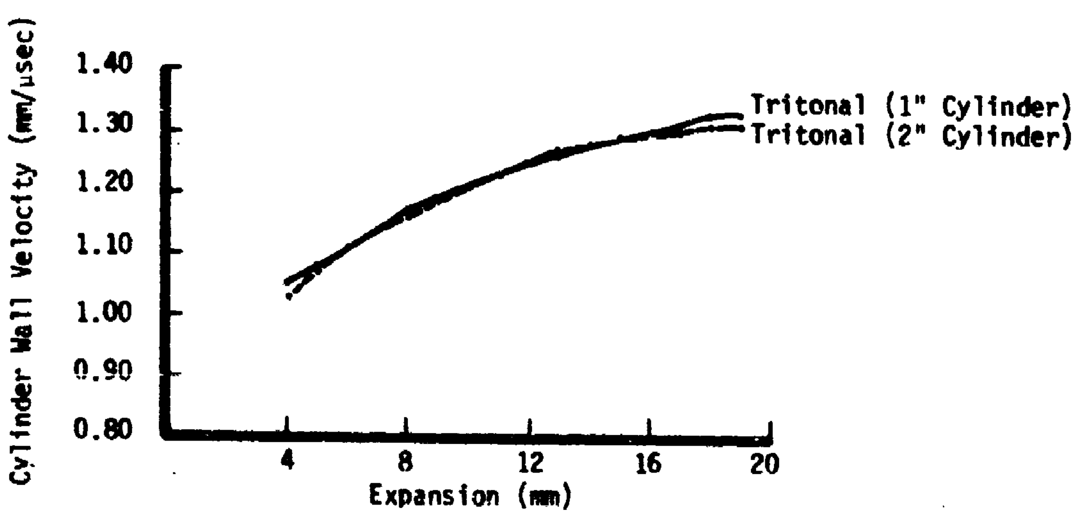

Figure 8. Comparison of Wall Velocities for 1- and 2-Inch Tritonal Cylinders

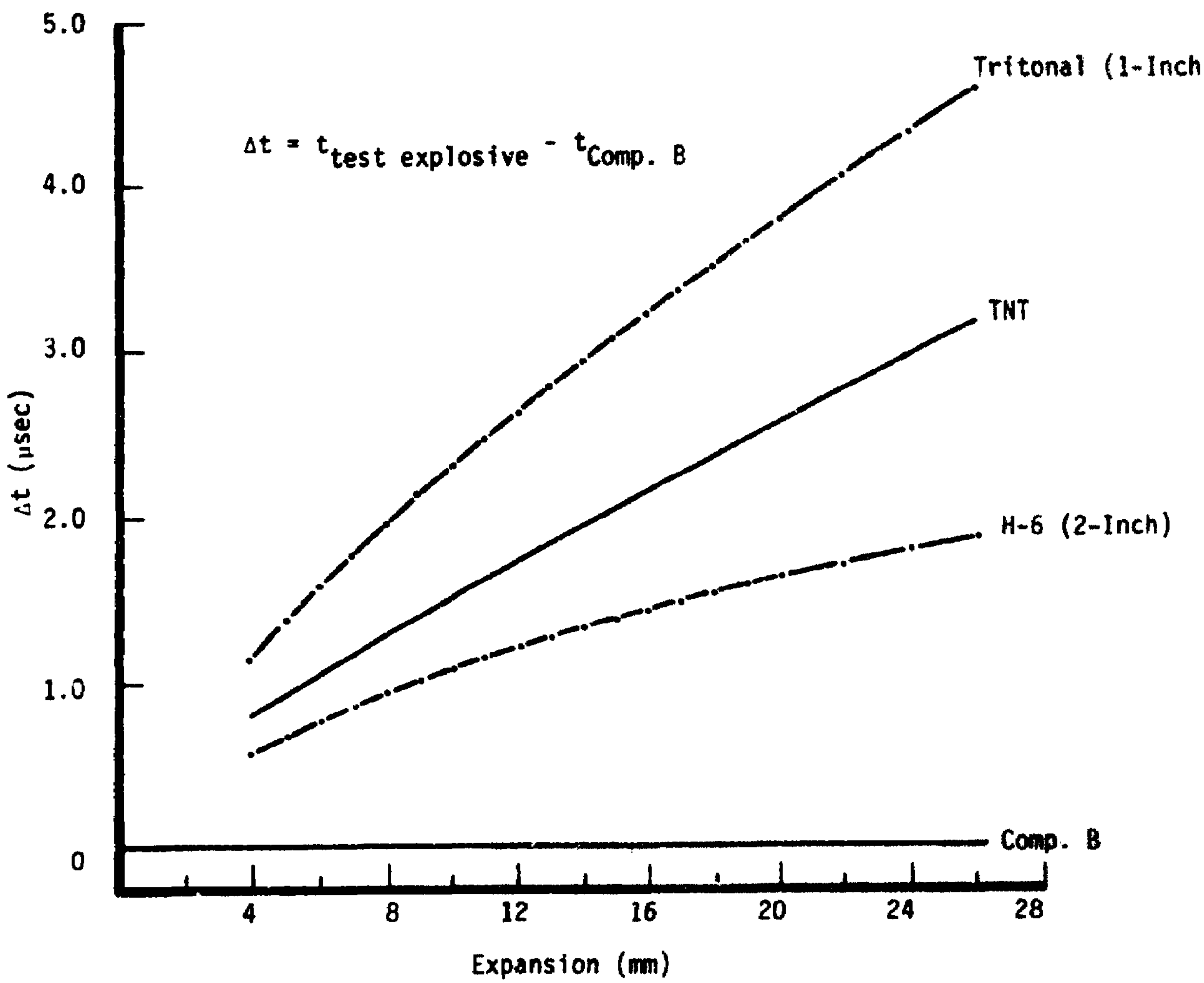

Figure 9. Relative Cylinder Wall Arrival Times Versus Expansion

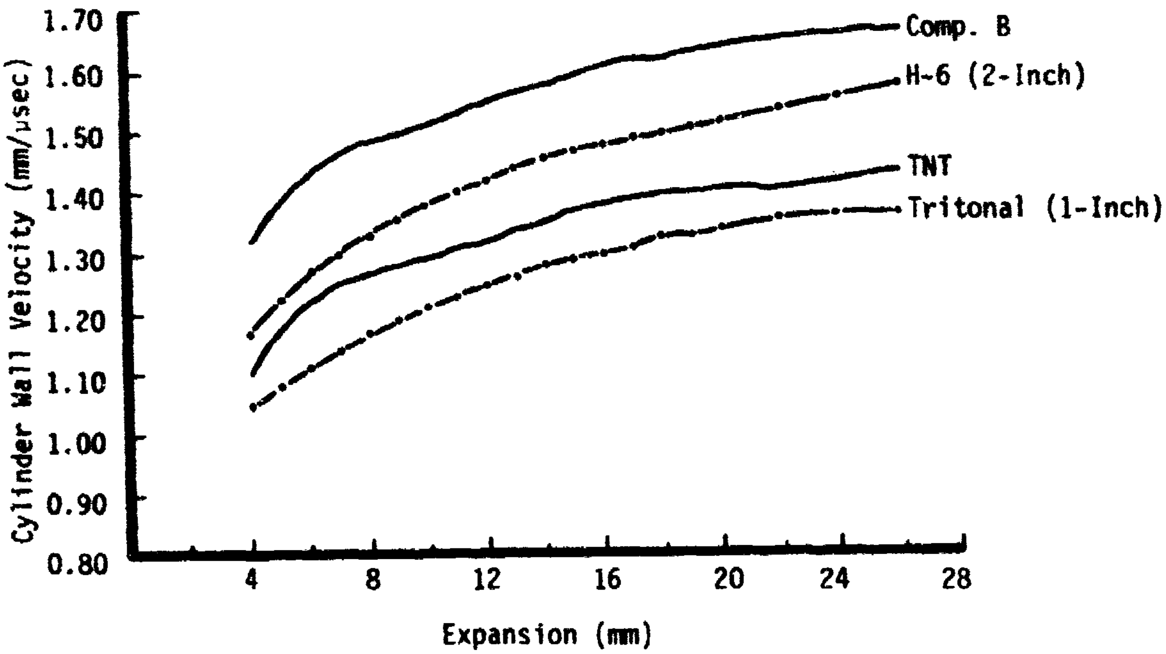

Figure 10. Cylinder Wall Velocity Versus Expansion

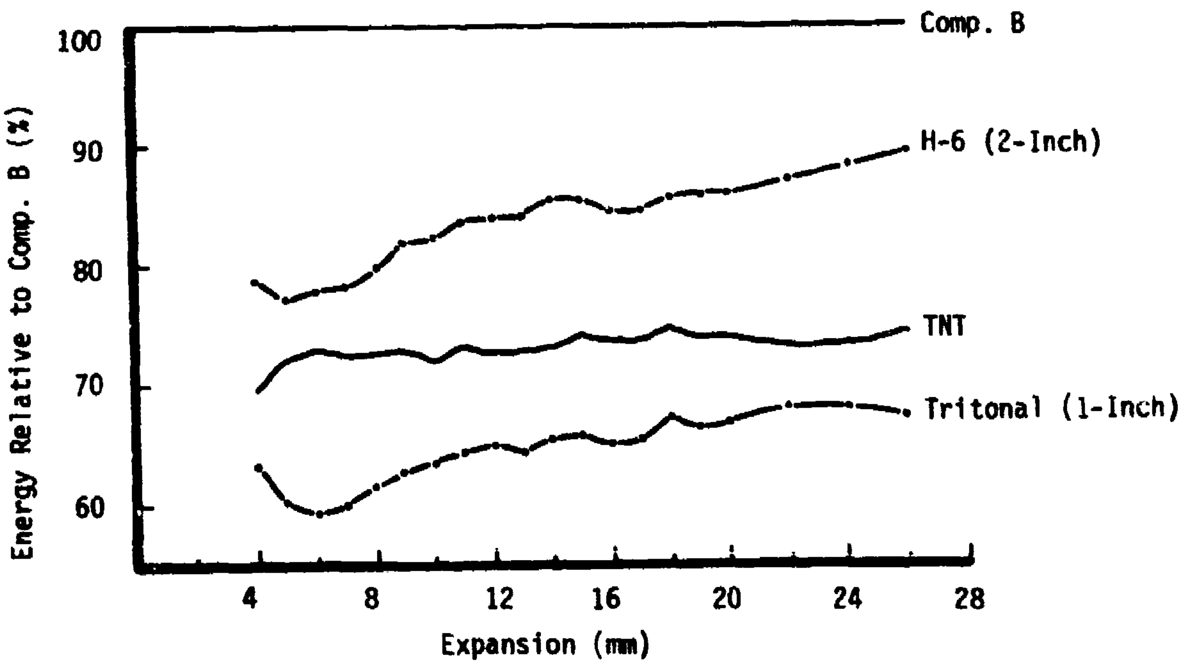

Figure 11. Relative Cylinder Wall Energy Versus Expansion

REFERENCES

1. G. T. West, C. C. Blair, G. L. Clink, J. H. Van Velkinburgh, "Some Sensitivity and Performance Characteristics of the Plastic Bonded Explosive PBXW-106," AFATL-TR-70-27.

2. G. T. West, C. C. Blair, G. L. Clink, R. J. Slape, "Some Sensitivity and Performance Characteristics of the Plastic Bonded Explosive PBXW-107," AFATL-TR-71-38.

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